Payne's team spends a couple of days at this western Idaho site and revisits it over several years to determine if the crust has changed position for an EarthScope research project.

INL seismologist doesn't wait for shakes to advance earthquake science

By Sandra Chung, *INL Research Communications Fellow*

The earthquake that brought seismologist Suzette Payne to Idaho National Laboratory lasted less than a minute. But nearly 28 years after the Borah Peak quake, Payne's passion for studying the way the Earth's crust shakes, breaks and moves is still going strong.

At 8:06 a.m. on Oct. 28, 1983, the Lost River fault ruptured near Idaho's Borah Peak and set off the largest and most destructive Idaho earthquake in recorded history. About 60 miles to the southeast, the tremor triggered a protective system that automatically shut down INL's Advanced Test Reactor. Inspectors found no serious damage to the lab's facilities, and ATR safely came back online. But the quake prompted INL to intensify its study and monitoring of the region's seismic and volcanic activity.

The tan feature terminating in the lower right corner is a fault scarp — a feature on the earth's surface — produced by the 1983 Borah Peak earthquake.

Payne was hired to expand the small INL seismic monitoring network. Under her leadership, five seismic stations became 27, and a dozen building motion monitors became 32.

Work by INL and independent researchers has shown that there is a good deal of seismic activity in the mountainous regions north and south of the INL site, but the Snake River Plain — where INL facilities are located — is much less active.

And Payne has contributed to that knowledge.

"She's guided us in different directions for bettering the network," says Jed Hodges, an INL seismic technician. Hodges has worked for Payne for 17 of his 20 years at INL. In the early 2000s, he and colleague Robert Berg were instrumental in making the INL monitoring network one of the first small seismic networks in the world to go completely digital.

The Continuous Global Positioning System (GPS) and seismic station at Great Rift, Idaho.

Payne describes Hodges and Berg as "invaluable" to the seismic monitoring program. Hodges says the same about Payne. "Many times we've battled difficult budget cuts. She's kept this seismic network alive," Hodges says.

Alive, and thriving, according to colleagues.

"It's a word-class network, tied into all the other networks in the country," says Richard Smith, a retired INL geologist who worked alongside Payne for 17 years. "If something like the Borah Peak earthquake were to happen again, we would be miles ahead in knowing how to deal with it."

But it may be a long while before something like Borah Peak happens again. Large, destructive earthquakes are relatively rare in these parts. "Here you are, a seismologist in Idaho, and you're bored silly because there are no earthquakes," Payne says, throwing up her hands.

From what her resume and her colleagues say about her, Payne doesn't have time to get bored. She earned her master's degree in geology from Boise State University while working full-time at INL. In a few months she'll have her doctorate from Idaho State University. She's become a regional expert in volcanology, geology and seismology while championing the INL seismic monitoring network. And she's led INL projects on everything from earthquake building safety to giant centrifuge construction. All while raising three children and volunteering at her church and at local schools.

"I just don't see how she has time to do all that stuff and do it well. But she does," Smith says. "We always had a joke that if we ever had a project we wanted to get done, all we had to do was tell Suzette it couldn't be done, and then turn her loose."

Lava leads the way

Payne, a Pittsburgh native, earned high marks in grade school math and science. A counselor advised her to study engineering. But she'd already found her earth science calling in a film she'd seen in second grade: "I remember this guy standing in front of lava as it flowed down the road," she says with wonder.

Suzette Payne sets the GPS receiver at a study site along Highway 95 in western Idaho.

Payne earned her undergraduate degree in seismology at the University of Utah and worked on an aftershock survey for the Borah Peak quake before she landed the seismologist job at INL. One of Payne's chief responsibilities is to coordinate regular seismic hazard assessments, which gauge the risk to INL facilities from earthquake and volcanic activity and make recommendations for building construction.

Nuclear facilities have to be capable of withstanding all manner of natural disasters, from earthquakes to floods to tornadoes. But "you can't just come up with answers that mean you have to build a building you can't afford," Payne says. So she rounds up a diverse panel of outside experts to help generate practical solutions with thorough scientific support.

Backing up the seismic hazard assessments with sound science is essential; it prepares the scientists to defend the assessments against outside challenges. In the mid-1990s, one such challenge came from university researchers.

"There was an article in the Idaho Statesman saying that INL was sitting in a geologic gun barrel," Smith says.

He and Payne had to argue their case in front of a special review panel and hostile audiences. "It was a heated time," Smith says.

The review panel ultimately ruled in favor of the INL assessment. Smith considers the outcome a credit to the depth of Payne's knowledge and her ability to speak about the science. "You cannot go into a meeting like that unless you know more about the subject matter than anyone else in the room," Smith says. "And Suzette was always prepared that way."

A subtler approach to earthshaking science

When she's not making sure INL knows how and where to build earthquake-resistant structures, Payne is working with collaborators at INL, MIT and Portland State University on a frontier in seismology and geology research.

The researchers are using GPS measurements to study movements of the Earth's crust in and around Idaho. Seismic monitors detect large, abrupt changes in the crust. With GPS, scientists can study smaller and slower events, including "silent" earthquakes, which last several hours or days. Subtle information from GPS measurements is already adjusting our understanding of earthquakes past, present and future.

Jed Hodges conducts a performance check of seismic station instrumentation at Bear Canyon in Idaho's Lemhi mountains.

Most of us think of earthquakes as a product of major faults like the San Andreas in California, where the edge of one tectonic plate rubs against another. But eastern Idaho isn't on the edge of a plate; it's much closer to the middle. Here, and in nearby Wyoming and Utah, Payne's GPS results suggest that the Earth's crust is slowly stretching like the top of a rising cake. Pieces of a stretching crust can cause earthquakes as they break away from each other. That's what happened on the Lost River fault during the Borah Peak earthquake.

The Lost River fault corresponds to one of three parallel mountain ranges northwest of the eastern Snake River Plain and the INL desert research facility. In a 2008 paper in the journal *Geology*, Payne and her collaborators wrote that GPS data from the past 15 years suggest that the mountain region is stretching around 10 times faster than the plain.

The faster the crust stretches, the faster it builds up massive amounts of strain, and the more frequently earthquakes occur to relieve that strain. The lower strain rate on the plain seems to correspond to its lower seismic activity.

Many of the GPS findings correspond well with traditional geological and seismic evidence – most everyone agrees that the crust in the American West is slowly expanding. But some of the details are more controversial.

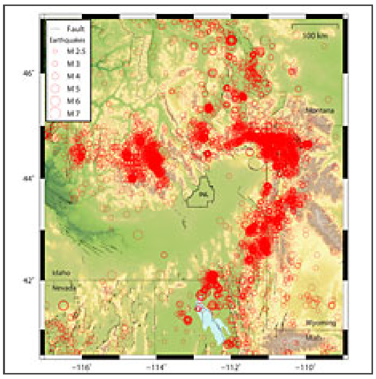
For instance, based on the GPS and seismic data, "You'd expect mountains and underground magma running along the edge of the range on the northwest side of the INL Site," Payne says.

Smith thinks the explanation might be volcanic. Magma welling up into the crust can cause earthquakes and form new faults; it can also fill in the gaps formed when the crust stretches. The last volcanic eruption on the Snake River Plain was 2,000 years ago. Future volcanic activity might expand the crust in the plain and help it catch up with the more swiftly stretching mountain region to the northwest, Smith says.

Payne isn't certain that magma alone will resolve the difference in strain rates. But she does know that magma plays an underappreciated role in earthquake activity. She and her colleagues wrote a chapter about the issue for a major seismology textbook. They argue that people who study earthquake history may be missing a big piece of the picture if they don't take nearby volcanic activity into account.

Enduring enthusiasm

"The stuff I'm doing here I never would have dreamed of years ago," she says. "When I started at INL, we located earthquakes with strings on a map."



Red circles show magnitude-2.5 and greater earthquakes from 1850 to 2007 within 200 miles of the INL site.

Although seismic technology and analytical techniques have changed substantially since she began her career, Payne still tackles research and practical questions with the indefatigable spirit of someone much fresher to the field. She betrays her enduring enthusiasm in the vivid way she describes the earthquakes and lava fields of eastern Idaho. A petite woman with long, dark hair, Payne mimes fault movements with her hands as she speaks. Were she a university professor, her lectures would likely be quite popular.

"Her passion and drive for seismology – it kind of rubs off on you," Hodges says. Hodges says he sometimes finds himself talking about seismology with his friends and family. "Anything I tell 'em is something I learned from her."

Payne frequently volunteers for student programs and speaks at nearby schools. Her dark eyes light up as she talks about helping students at Hillcrest Elementary make balsa wood structures and test them for earthquake worthiness.

She chuckles when she describes a high school student surprising her with a precocious question about the East African Rift. It turned out the student's father was one of Payne's scientific colleagues, she says.

Payne goes on to explain that the Great Rift of Idaho is the biggest and youngest volcanic rift system in the Snake River Plain, and the East African Rift system is a much larger active system with similar magmatic processes. Someday, she says, she'd like to journey to the African continent and visit that rift system. "Now that would be cool," she says.

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